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Work under Task 1 has begun on the evaluation of candidate high temperature transient liquid phase sintering (TLPS) systems as well as candidate high temperature polymer materials. In evaluating condidate metal and alloy systems, binary and available ternary phase diagrams are being reviewed to identify alloy systems that could be used in a high temperature application. The goal is to find a combination of metals and alloys that will go through TLPS at a temperature compatible with the polymer processing and that will form products that will be able to withstand the proposed high operating temperatures. DSC studies of some of these combinations have been done to confirm their potential. Metal powders studied so far include copper and various low melting point metals and alloys to ascertain the products formed by TLPS.

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PROGRESS REPORT #1

Polymer Based Materials for Additive Processing of High Temperature Electronics Packaging

October 3, 1994

Work on the project commenced on September 1. The principal and co-principal investigators met the first week to plan the general strategy for the project. This project will be done with the assistance of Dr. Linda Domeier of Sandia Laboratories in Livermore. The Cooperative Research and Development Agreement (CRADA) with Sandia is being finalized and a tentative kick-off meeting has been set up for mid-October. Full project strategies and apportionment of tasks will be done at that time.

In the meantime, work under Task 1 has begun on the evaluation of candidate high temperature transient liquid phase sintering (TLPS) systems as well as candidate high temperature polymer materials. In evaluating candidate metal and alloy systems, binary and available ternary phase diagrams are being reviewed to identify alloy systems that could be used in a high temperature application. The goal is to find a combination of metals and alloys that will go through TLPS at a temperature compatible with the polymer processing and that will form products that will be able to withstand the proposed high operating temperatures. DSC studies of some of these combinations have been done to confirm their potential. Metal powders studied so far include copper and various low melting point metals and alloys to ascertain the products formed by TLPS.

Thermal cure of the proposed inks will be done either in a vapor phase oven or in an IR oven to guarantee simultaneous cure of the polymer and the TLPS of the metals. Under Task 2, several experimental formulations of standard polymer ink have been made using the new combinations of powders to observe their sintering ability. This work was hampered by the lack of a high enough processing temperature in the vapor phase cure. A high temperature liquid (250°C) was obtained from the manufacturer, but this proved insufficient for complete cure of the systems tested. Partial sintering was observed and DSC scans of the ink confirmed the capability of these systems. Further work will be done on finding and evaluating candidate TLPS systems. It is also expected that an IR oven will be obtained within a month which would allow complete testing of these systems as well as the polymers chosen in Task 3.

Under Task 3, candidate resin families were evaluated for appropriate thermal and moisture properties by analysis of product data sheets of commercially available products. A purchase list of candidate resins to be employed in co-polymers in the conductive ink system and in the compatible dielectric material was assembled and sample quantities have been ordered.

Thermal analysis has been performed on the current proprietary flux and cross-link system in conjunction with representative samples of high temperature commercial resins to determine the thermal coefficients of expansion and glass transition temperatures of these types of co-polymers. Preliminary results suggest that the goal thermal properties of this research will be achievable with the chemical families selected.

A preliminary dielectric formulation has been developed. It has been demonstrated to provide very good adhesion to both the aluminum substrate material and the standard conductive ink formulations. Additional work will be performed to determine its dielectric characteristics under severe temperature and humidity conditions. A general plan has been developed to adapt this formulation for compatibility to the organic materials selected for the high temperature version of these inks.

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